

**EFFICIENCY ENHANCEMENT OF CUCKOO  
SEARCH OPTIMIZATION TECHNIQUE FOR  
IMAGE COMPRESSION**

*Dissertation submitted in fulfilment of the requirements for the Degree of*

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**in**

**COMPUTER SCIENCE AND ENGINEERING**

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## **ABSTRACT**

Study and analysis has been done on the most popular now-a-days, image compression. Recently research has been done by doing hybridization with two techniques i.e Cuckoo-Search and Linde-Buzo-Gray, CS-LBG in 2016 and their results proved that it is 1.4125 times slower as compared to other techniques. So, we have worked on this limitation by doing hybridization of two algorithms i.e. Cuckoo-Search and Kekre's Fast Codebook Generation Algorithm, CS-KFCG. We observed that LBG is quite slower as compared to KFCG in generating codebook of different sizes so it may be the reason of slowing down CS-LBG. So, we implemented CS-KFCG on five images and noticed that the PSNR values of our proposed method is giving higher PSNR values as compared to CS-LBG and also the computational time is decreased in our case as compared to CS-LBG. Finally, we have proved that our algorithm gives efficient Cuckoo search technique for compressing the images. It can be used in many applications where we use to send images or store images. The originality of the image is lost once it is sent through any application or any cloud service.

## **KEYWORDS**

The keywords which the content of our dissertation are:

- i. Image Compression
- ii. Vector Quantization
- iii. Cuckoo-Search
- iv. Kekre Fast Codebook Generation
- v. CS-KFCG

## **DECLARATION**

I hereby declare that the research work reported in the dissertation entitled ‘**EFFICIENCY ENHANCEMENT OF CUCKOO SEARCH OPTIMIZATION FOR IMAGE COMPRESSION**’ in fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. Aditya Bakshi. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University’s Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

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## SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation entitled ‘**EFFICIENCY ENHANCEMENT THE CUCKOO SEARCH OPTIMIZATION TECHNIQUE FOR IMAGE COMPRESSION**’, submitted by **Rausheen Bal** at **Lovely Professional University, Phagwara, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

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# CHAPTER 1

## INTRODUCTION

### 1.1 IMAGE PROCESSING

Image processing is the investigation of any calculation that takes an image as input and returns an image as output [1]. Image Processing includes: Image show and printing, Image altering and control, Image improvement, Feature identification, Image compression[1]. Image Processing has several applications such as in medical diagnosis, security (biometrics), removing the noise from the images, contrast adjustment, edge detection, region detection, segmentation, image compression, restoring the damaged images. An image[2] might be characterized as a two-dimensional function,  $f(x, y)$ , where  $x$  and  $y$  are spatial directions, and the abundance of  $f$  at any combination of directions  $(x, y)$  is known as the power or intensity level of the image at that point. Whenever  $x$ ,  $y$ , and the intensity estimations of  $f$  are all limited, discrete amounts, we call the image a computerized image[2]. The field of advanced image processing alludes to handling computerized images by methods for an advanced PC. Take note of that a computerized image is composed of a limited number of components, each of which has a specific area and intensity. These components are alluded to as image components, image components, pixels, and pixels[2]. Pixel is the term most broadly used to signify the components of an advanced image. There are two types of image processing.

#### 1.1.1 Analog Image Processing

It is utilized to the change of image over electrical means. A definitive general case is the TV image. The TV flag is a power level which changes in abundance to show brilliance over the image. By electrically fluctuating the flag, the exhibited image appearance is changed. The shine and banter on a TV set give to change the adequacy and reference of the video flag, creating in the help, diminish and adjustment of the help scope of the introduced image.

### **1.1.2 Digital Image Processing**

In this situation, digital computers are utilized to develop the image. The image will be reformed to digital form applying a scanner and then process it. It is illustrated as the regulating numerical images of objects to a sequence of operations in consideration of obtaining a aimed result. It commences with one image and outgrowths are altered form of the same. It is thus a procedure that captures an image into another. The term is known as digital image processing normally mentions to processing of a two-dimensional image by a digital computer. In wider circumstances, it indicates digital processing of any two-dimensional data. A digital image is actually an array of real numbers depicted by a fixed number of bits. The standard benefit of Digital Image Processing techniques is its adaptability, flexibility, repeatability and the maintenance of original data accuracy. Approaches of Image Processing[3] have some fundamental steps as follows:

**Image Acquisition:** This is the first step or process of the fundamental steps of digital image processing. Image acquisition[3] could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves preprocessing, such as scaling etc.

**Image Enhancement:** Image enhancement[3] is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Such as, changing brightness & contrast etc.

**Image Restoration:** Image restoration[3] is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

**Color Image Processing:** Color image processing[3] is a range that has been picking up its significance in light of the critical increment in the utilization of advanced images over the Internet. This may incorporate shading demonstrating and handling in an advanced area and so forth.

Wavelets Processing: Wavelets[3] are the establishment for speaking to images in different degrees of determination. Images subdivision progressively into littler locales for information compression and for pyramidal portrayal.

Compression: Compression[3] manages procedures for decreasing the capacity required to spare a image or the transmission capacity to transmit it. Especially in the employments of web it is particularly important to pack information. There are two sorts of compression techniques[4] named as lossy compression and lossless compression.

- Lossless Compression: Lossless compression technique[4] includes no loss of data, if the information has been losslessly compacted, the first information can be recuperated precisely from the packed information.
- Lossy Compression: Lossy compression technique[4] includes some loss of data, and the information that have been compacted utilizing lossy strategies for the most part can't be recuperated precisely.

Morphological Processing: Morphological processing[3] manages devices for separating image segments that are valuable in the portrayal and depiction of shape.

Segmentation: Segmentation[3] methodology segment a image into its constituent parts or questions. When all is said in done, self-sufficient division is a standout amongst the most troublesome assignments in advanced image handling. A tough division method brings the procedure far toward effective arrangement of imaging issues that oblige articles to be distinguished separately.

Representation and Description: Representation[3] and depiction quite often take after the yield of a division stage, which for the most part is crude pixel information, constituting either the limit of a locale or every one of the focuses in the district itself. Picking a portrayal is just piece of the answer for changing crude information into a frame appropriate for resulting PC preparing. Description manages removing properties that outcome in some quantitative data of intrigue or are essential for separating one class of articles from another.

Object acknowledgment: Recognition [3]is the procedure that doles out a name, for example, "vehicle" to a protest in view of its descriptors.

Knowledge Base: Knowledge[3] might be as basic as specifying areas of a image where the data of premium is known to be found, hence constraining the pursuit that must be led in looking for that data. The information base additionally can be very mind boggling, for example, an interrelated rundown of all real conceivable deformities in a materials review issue or a image database containing high-determination satellite images of an area regarding change-identification applications.

## **1.2 IMAGE COMPRESSION**

Image compression[5] is limiting the size in bytes of an illustrations document without corrupting the nature of the image to an unsuitable level. The lessening in record estimate enables more images to be put away in a given measure of circle or memory space. It likewise decreases the time required for images to be sent over the Internet or downloaded from Web pages. There are a few distinctive routes in which image records can be packed. For Internet utilize, the two most regular compacted realistic image arrangements are the JPEG organize and the GIF design. The JPEG technique is all the more regularly utilized for photos, while the GIF strategy is generally utilized for line workmanship and different images in which geometric shapes are moderately basic. A text file or program can be compressed without the introduction of errors, but only up to a certain extent. This is called lossless compression[5]. Beyond this point, errors are introduced. In text and program files, it is crucial that compression be lossless because a single error can seriously damage the meaning of a text file, or cause a program not to run. In image compression[5], a small loss in quality is usually not noticeable. There is no "critical point" up to which compression works perfectly, but beyond which it becomes impossible. When there is some tolerance for loss, the compression factor can be greater than it can when there is no loss tolerance. For this reason, graphic images can be compressed more than text files or programs.

## **1.3 QUANTIZATION**

Quantization[6], included in image preparing, is a lossy compression procedure accomplished by packing a scope of qualities to a solitary quantum esteem. At the point when the quantity of discrete images in a given stream is decreased, the stream turns out to be more compressible. For instance, diminishing the quantity of hues required to speak to an advanced image makes it conceivable to decrease its record

estimate. There are two sorts of quantization i.e. scalar quantization and vector quantization.

### **1.3.1 Scalar Quantization**

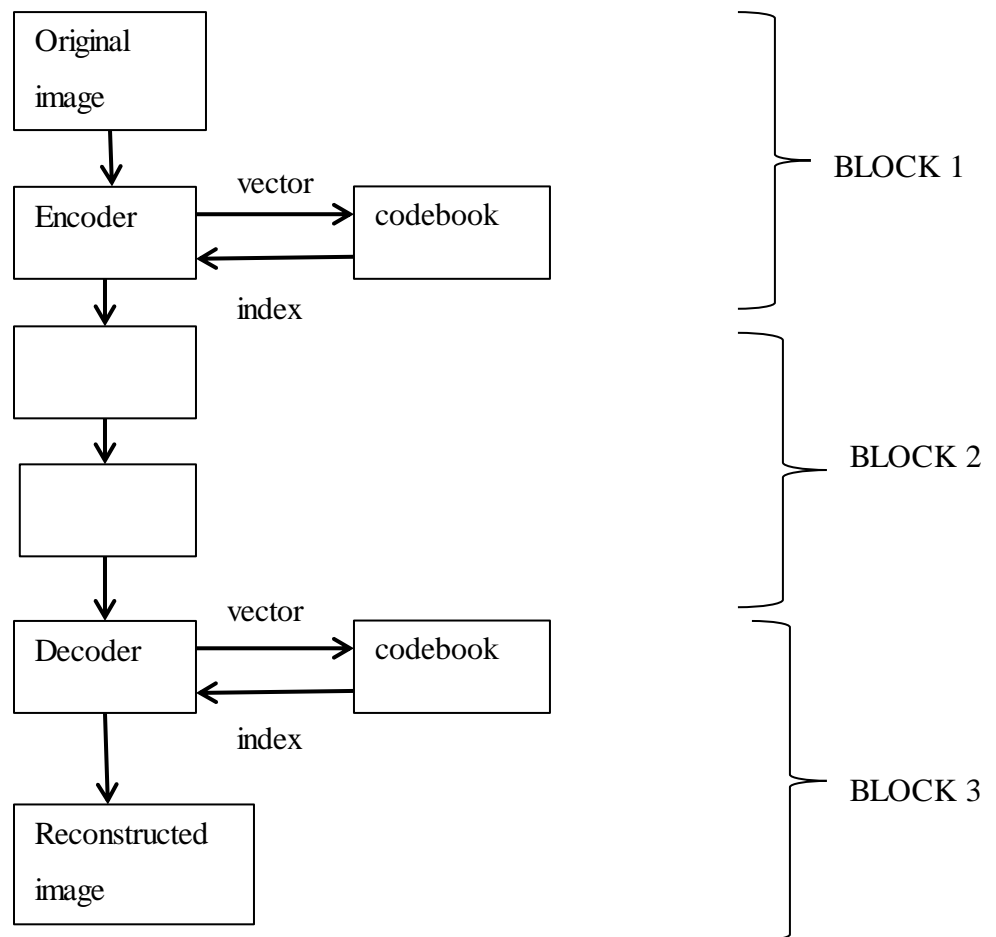
Quantization is a procedure of speaking to an expansive – conceivably vast – set of qualities with a considerably littler set. Scalar quantization[7] is a mapping of an info esteem  $x$  into a limited number of yield qualities,  $y$ :  $Q: x \text{ infers } y$ . Huge numbers of the principal thoughts of quantization and compression are effectively presented in the basic setting of scalar quantization[7].

### **1.3.2 Vector Quantization**

Vector quantization [8] (VQ) is an established quantization system from flag handling that permits the demonstrating of likelihood thickness works by the circulation of model vectors. It was initially utilized for compression. Vector quantization [8] is appropriate for lossy information compression, lossy information revision, design acknowledgment, image compression, discourse acknowledgment, confront location, thickness estimation and grouping and so on. Vector quantization,[8] additionally called "square quantization" or "example coordinating quantization". Vector quantization [9] being a non-changed compression procedure, is a capable and productive apparatus for lossy image compression. The fundamental point of vector quantization[9] was to plan a proficient codebook that contains a gathering of codewords to which include image vector is appointed in view of the base Euclidean separation. The essential and most utilized vector quantization system is Linde Buzo Gray (LBG) calculation (in 1980) [10]. Vector Quantization is done in three stages encoder, channel and decoder[9]. The schematic graph of Vector Quantization is appeared in Figure 1. 1 The chart comprises of three squares in which each piece has an alternate working principle[9]. Square 1 is the encoder segment which incorporates era of image vectors, codebook era and indexing[9]. Image vectors are created by subdividing the info image into prompt and non-covering blocks[9]. Era of productive codebook is the real errand in vector quantization. A codebook contains a gathering of codewords of size equivalent to nonoverlapping square measure. A calculation is said to be better calculation if its produced codebook is efficient[9]. After a fruitful era of the codebook, every vector is ordered with the record number from list table[9]. These list numbers are transmitted to the beneficiary. Piece 2 is the channel through which



ordered numbers are transmitted to the receiver[9]. Square 3 is a decoder segment which incorporates list table, codebook and remade image[9]. The got listed numbers are decoded with collector file table. The codebook at the collector is the same as that of transmitter codebook[9]. The got record numbers are allotted to its comparing codewords and these codewords are orchestrated in a way that the measure of the recreated image is the same as that of the information image[9]. Vector quantization is better over scalar quantization in light of the fact that the storage room possessed in vector quantization is less when contrasted with scalar quantization in light of the fact that in vector quantization the information is put away as squares and we know blocks consumes less space.



**Figure 1.1 Procedure of Vector Quantization**

## **1.4 ABOUT MATLAB 2014a**

MATLAB 2014a belongs to version MATLAB 8.3. In this version Simplified compiler setup for building MEX-files; USB Webcams support in core MATLAB; number of local workers no longer limited to 12 with Parallel Computing Toolbox were introduced and it came into existence on March 7, 2014[11]. The implementation uses MATLAB 2014a version 8.3[11] on intel i3 processor 4GB RAM. Computational time depends upon the processor. MATLAB is known as MATRIX LABORATORY[11]. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python[11].

## CHAPTER 2

### REVIEW OF LITERATURE

#### **Algorithm for Vector Quantizer Design, Linde et.al [10]**

It is a proficient, and instinctive calculation is introduced for the outline of vector quantizers construct either with respect to a known probabilistic model or on a long preparing succession of data[10]. The essential properties of the calculation were examined mid shown by cases. Very broad bending measures and long piece lengths are permitted, as exemplified by the outline of parameter vector quantizers of ten dimensional vectors emerging in Linear Predictive Coded (LE)[10] discourse compression with a convoluted mutilation measure emerging in LPC examination that does not depend just on the mistake vector[10]. LBG calculation is basic, versatile and adaptable, and depends on the base Euclidean separation between the image vector and relating codeword [9]. It delivers a neighborhood ideal arrangement however, does not ensure the best worldwide arrangements. LBG calculation last arrangement relies on upon beginning codebook which is produced randomly[9].

#### **Enhanced LBG Algorithm, Patane et.al [12]**

Patane and Russo proposed an upgraded LBG (ELBG) calculation that enhances the neighborhood ideal arrangement of LBG calculation [12]. The essential thought of ELBG is ideal utility of codewords, a capable instrument to defeat the fundamental downsides of grouping calculations and the outcome indicates preferred execution over LBG and its execution is free on introductory codebook[12].The scientists exhibited the new bunching calculation called as Enhanced LBG calculation (ELBG) [12]. It has a place with the hard and k-implies vector quantization gatherings and gets specifically from the less difficult LBG. The essential thought they had created was the idea of utility of a codeword, an effective instrument to beat one of the primary downsides of bunching calculations: for the most part, the outcomes accomplished are bad on account of an awful decision of the underlying codebook[12]. They spoke to their exploratory outcomes demonstrating the ELBG can discover preferable codebooks over past bunching strategies and the computational unpredictability is for all intents and purposes the same as the more straightforward LBG[12].

## **Image Compression Method using Improved PSO Vector**

### **Quantization, Chen et.al [13]**

VQ coding is an intense method in computerized image compression. Conventional techniques, for example, exemplary LBG calculation dependably create nearby ideal codebook[13]. In this, scientists presented Particle Swarm Optimization (PSO) bunch strategy to fabricate astounding codebook for image compression[13]. They additionally set the aftereffect of LBG calculation to introduce worldwide best molecule by which it can speed the merging of PSO[13]. Both image encoding and unraveling procedure were reenacted in our examinations. Results were demonstrated that the calculation is dependable and the reproduced images get higher quality to images remade by other methods[13]. In this they utilized PSO technique introduced by LBG strategy to produce VQ codebook for image compression[13]. The aftereffect of examinations demonstrated it is an exceptionally powerful and the reconstructive images have higher quality than customary LBG technique. Besides, this strategy can likewise be utilized as a part of different applications, for example, image stockpiling, speaker acknowledgment etc[13].

### **A Novel quantum swarm evolutionary algorithm and its applications, Wang et.al [14]**

In this specialists presented, a novel quantum swarm developmental calculation (QSE) and was displayed in view of the quantum-motivated transformative calculation (QEA)[14]. Another meaning of Q-bit expression called quantum point is proposed, and an enhanced molecule swarm advancement (PSO) is utilized to refresh the quantum edges automatically[14]. The mimicked brings about tackling 0-1 rucksack issue demonstrate that QSE is better than conventional QEA[14]. Moreover, the correlation tests demonstrate that QSE is superior to numerous customary heuristic calculations, for example, climb slope calculation, reenactment strengthen calculation and forbidden inquiry algorithm[14]. In the interim, the test consequences of 14 urban areas voyaging sales representative issue (TSP) demonstrate that it is possible and successful for little scale TSPs, which shows a promising novel approach for tackling TSPs[14]. In this analysts, a novel QSE was displayed, which depended on the QEA[14]. A novel quantum bit expression instrument called quantum edge is utilized and the enhanced PSO is embraced to refresh the Q-bit automatically[14].

The reproduced brings about taking care of 0–1 backpack issue demonstrate that QSE is better than conventional QEA. The correlation tries likewise demonstrated that QSE is superior to numerous traditional heuristic calculations, for example, climb slope calculation, recreation toughening calculation and unthinkable hunt algorithm[14]. Likewise, the examination of tackling TSP shows that the proposed approach of QSE acquired the best come about via looking a little size extent of the arrangement space[14]. It had likewise demonstrated that a more terrible execution of the conduct was watched when the quantity of the urban communities increased[14]. This can be credited to the twofold string coding which we used to speak to the visit requests of the urban areas. The review on the confinement of the paired coding is in progress[14]. Future research works will incorporate how to locate a more powerful technique for picking the parameters as per the data of various problems[14].

## **A Powerful and Efficient Algorithm For Numerical Function**

### **Optimization: Artificial Bees Colony (ABC), Karaboga et.al [15]**

Swarm knowledge is an exploration branch that models the number of inhabitants in communicating specialists or swarms that can self-organize[15]. A subterranean insect settlement, a run of fowls or an insusceptible framework is a run of the mill case of a swarm system[15]. Honey bees' swarming around their hive is another case of swarm knowledge. Simulated Bee Colony (ABC) Algorithm is an improvement calculation in light of the canny conduct of bumble bee swarm[15]. In this work, ABC calculation was utilized for enhancing multivariable capacities and the outcomes were created by ABC, Genetic Algorithm (GA), Particle Swarm Algorithm (PSO) and Particle Swarm Inspired Evolutionary Algorithm (PS-EA) had been looked at. The outcomes demonstrated that ABC outflanked the other algorithms[15]. This paper were contrasted the execution of the ABC and that of GA, PSO and PS-EA which are additionally swarm insight and populace based calculations as the ABC algorithm[15]. With a specific end goal to show the execution of the ABC calculation, PSO, PS-EA, GA and ABC calculations were tried on five high dimensional numerical benchmark works that have multimodality[15]. From the recreation comes about it was inferred that the proposed calculation can escape a neighborhood least and can be effectively utilized for multivariable, multimodal work optimization[15]. There are a few issues which stay as the extensions for future reviews, for example,

the examination of the control parameters' impact on the execution of the ABC calculation and the joining pace of the algorithm[15].

## **An Efficient Fast Algorithm to Generate Codebook for Vector**

### **Quantization, Kekre et.al [16]**

In this paper they exhibited an extremely straightforward but then successful calculation to create codebook[16]. The calculation utilized sorting technique to produce codebook and the codevectors are acquired by utilizing middle approach[16]. The proposed calculation was probed six unique images each of size 512x512 and four diverse codebooks of sizes 128, 256, 512 and 1024 are generated[16]. The proposed calculation is observed to be considerably quicker than the LBG and KPE algorithm[16]. The execution of this calculation is superior to anything LBG and KPE calculations considering MSE, PSNR and execution time[16]. The proposed calculation gave less MSE when contrasted with the LBG for the codebooks of sizes 128, 256, 512 and 1024 respectively[16]. It additionally gave higher PSNR when contrasted with LBG for the codebooks of different sizes[16]. Another codebook era calculation is proposed[16]. It is watched frame the outcomes that the proposed calculation sets aside slightest opportunity to produce codebook, since it doesn't require Euclidean separation computation[16]. It additionally gives less MSE when contrasted with LBG and KPE calculations. It is additionally watched that their proposed calculation is on a normal 99.98% times quicker than LBG and KPE[16]. The execution of this calculation is superior to anything LBG and KPE calculations considering MSE, PSNR and execution time. The proposed calculation gave 20.70%, 31.22%, 37.30%, and 38.93% times less MSE when contrasted with the LBG for the codebooks of sizes 128, 256, 512 and 1024 individually. It likewise gives PSNR 1.0494, 1.7650, 2.2140 and 2.3428 dB more when contrasted with LBG for the codebooks of sizes 128, 256, 512 and 1024 respectively[16]. Despite the fact that in this paper they had contrasted their proposed calculation and LBG and KPE, it will be certainly productive, basic and quick when contrasted with other codebook era calculations when contrasted with spit and union [17], split and converge with consideration of GLA [17], Hyperplane approaches which utilizes chief segment investigation (PCA) strategy to create codebook [18], Directed Search Binary Splitting DSBS[19] for codebook era additionally utilizes PCA methods to locate the estimated

dissemination shape for each group.

## **Image Vector Quantization Algorithm via Honey Bee Mating**

### **Optimization, Horng et.al [20]**

The vector quantization (VQ) was a capable method in the uses of computerized image compression[20]. The customarily broadly utilized strategy, for example, the Linde–Buzo–Gray (LBG) calculation dependably created neighborhood ideal codebook. As of late, molecule swarm advancement (PSO) is adjusted to get the close worldwide ideal codebook of vector quantization. An option strategy, called the quantum molecule swarm streamlining (QPSO) had been produced to enhance the aftereffects of unique PSO calculation. In this paper[20], they connected another swarm calculation, bumble bee mating advancement, to build the codebook of vector quantization. The outcomes were contrasted and the other three techniques that are LBG, PSO–LBG and QPSO–LBG algorithms[20]. Trial comes about demonstrated that the proposed HBMO–LBG calculation is more solid and the reproduced images get higher quality than those created from the other three methods[20]. This paper gave a point by point portrayal of how the HBMO (bumble bee mating advancement) calculation can be utilized to execute the vector quantization and improve the execution of LBG method[20]. The majority of our exploratory outcomes demonstrated that the proposed calculation can expand the nature of reconstructive images as for other three techniques incorporated the customary LBG, PSO–LBG, and QPSO–LBG[20]. The proposed HBMO–LBG calculation can furnish a superior codebook with little contortion.

## **Artificial Bees Colony Algorithm Using Vector Quantization For**

### **Image Compression, Horng et.al [21]**

The vector quantization was an intense strategy in image compression[21]. The broadly utilized strategy, for example, the Linde-Buzo-Gray (LBG) calculation dependably created neighborhood ideal codebook[21]. As of late, molecule swarm enhancement was adjusted to get the close worldwide ideal codebook of vector quantization[21]. The option strategy called the quantum molecule swarm advancement was created to enhance the aftereffects of unique PSO algorithm[21]. The bumble bee mating improvement was utilized to build up the calculation for vector quantization[21]. In this paper, they proposed another strategy in view of the

manufactured honey bee province (ABC) calculation to build the codebook of vector quantization[21]. The proposed strategy utilized LBG technique as the underlying of ABC calculation to build up the VQ algorithm[21]. This strategy was called ABC-LBG algorithm[21]. The ABC-LBG calculation was contrasted and four calculations depicted above[21]. Test comes about demonstrated that the ABC-LBG calculation is more solid and the reproduced images get higher quality contrasted with other methods[21]. This paper gave a nitty gritty portrayal of how the manufactured honey bee province calculation was utilized to actualize the vector quantization and improved the execution of LBG method[21]. The majority of their trial comes about demonstrated that the ABC-LBG calculation can expand the nature of reconstructive images regarding other four techniques, for example, the customary LBG, the PSO-LBG, the QPSO-LBG and HBMO-LBG algorithm[21]. The proposed ABC-LBG calculation can furnish a superior codebook with littlest distortion[21].

## **Vector Quantization Using Firefly Algorithm for Image**

### **Compression, Horng et.al [22]**

The vector quantization (VQ) was an intense procedure in the utilizations of computerized image compression[22]. The customarily generally utilized strategy, for example, the Linde–Buzo–Gray (LBG) calculation dependably created neighborhood ideal codebook[22]. As of late, molecule swarm enhancement (PSO) was adjusted to get the close worldwide ideal codebook of vector quantization[22]. An alternative technique, called the quantum molecule swarm streamlining (QPSO) had been created to enhance the consequences of unique PSO algorithm[22]. The bumble bee mating enhancement (HBMO) was likewise used to build up the calculation for vector quantization[22]. In this paper, they proposed another technique in view of the firefly calculation to build the codebook of vector quantization. The proposed strategy utilized LBG technique as the underlying of FF calculation to build up the VQ algorithm[22]. This technique was called FF-LBG algorithm[22]. The FF-LBG calculation was contrasted and the other four techniques that are LBG, molecule swarm advancement, quantum molecule swarm enhancement and bumble bee mating improvement algorithms[22]. Test comes about demonstrate that the proposed FF-LBG calculation is speedier than the other four methods[22]. Besides, the reproduced images get higher quality than those produced frame the LBG, PSO and QPSO, however it is no noteworthy prevalence over the HBMO algorithm[22]. This paper



gave a definite depiction of how the firefly calculation uses to execute the vector quantization and improve the execution of LBG method[22]. The greater part of their test comes about demonstrated that the FF-LBG calculation can expand the nature of reconstructive images as for other three techniques, for example, the customary LBG, the PSO-LBG, and QPSO-LBG[22]. Moreover, the exploratory outcomes demonstrated that their proposed FF-LBG calculation is as dependable as the HBMO-LBG calculation; in any case, the FF-LBG needs considerably less the calculation time and the quantity of parameters than the HBMO-LBG algorithm[22].

### **An Adaptive Image Enhancement Technique by Combining Cuckoo Search and Particle Swarm Optimization Algorithm, Ye et.al [23]**

Image upgrade is a critical system of image handling and analysis[23]. This paper displayed another strategy utilizing an adjusted measure and mixing of cuckoo hunt and molecule swarm improvement (CS-PSO) for low difference images to upgrade image adaptively[23]. Along these lines, differentiate upgrade is acquired by worldwide change of the information forces; it utilizes fragmented Beta capacity as the change work and a novel paradigm for measuring image quality considering three elements which are edge, entropy esteem, and dark level likelihood thickness of the image[23]. The improvement procedure is a nonlinear enhancement issue with a few constraints[23]. CS-PSO is used to amplify the target wellness measure keeping in mind the end goal to upgrade the differentiation and detail in a image by adjusting the parameters of a novel augmentation to a neighborhood improvement technique[23]. The execution of the proposed strategy has been contrasted and other existing procedures, for example, direct complexity extending, histogram evening out, and transformative registering based image improvement techniques like backtracking hunt calculation, differential pursuit calculation, hereditary calculation, and molecule swarm enhancement as far as handling time and image quality[23]. Test comes about show that the proposed strategy is hearty and versatile and displays the preferred execution over different strategies required in the paper[23]. In rundown, a CS-PSO based image improvement strategy for dark level images is proposed and a novel foundation for measuring nature of the upgraded image is given in the paper[23]. Aftereffects of the proposed strategy are contrasted and some other image improvement systems, as straight differentiation extending, histogram leveling, and inadequate Beta capacity based image upgrade technique enhanced with Bijective

DSA, BSA, GA, PSO, and CS[23]. It is watched that developmental calculation can be all around utilized as a part of image improvement as per the nature of upgraded image[23]. In the mean time, target work assumes an unequivocal part in assessing the improved image[23]. Among these techniques, our strategy can rapidly and steadily focalize to the ideal arrangement and the target capacity is likewise superior to other methods[23].

## **Visually Lossless Compression for Bayer Color Filter Array using Optimized Vector Quantization, Lakshmi et.al [24]**

Gadgets utilizing single sensors to catch shading images are less expensive because of high cost of Charge Couple Device(CCD) sensors or Complementary Metal-Oxide Semiconductor (CMOS) sensors[24]. Single sensor gadgets utilize Color Filter Array (CFA) to test one shading band at each pixel location[24]. De mosaicking procedure is connected to insert the two missing hues from the surrounding[24]. Commonly compression was done on the de mosaicked images which may not be effective because of the individual compression of the diverse shading space[24]. Their work examined compression of crude information before de mosaicking and performs de mosaicking to remake the R, G, B groups later[24]. A novel Vector Quantization (VQ) system for encoding the wavelet disintegrated image utilizing Modified Artificial Bee Colony (ABC) enhancement calculation was proposed[24]. The proposed strategy was contrasted and Genetic Algorithm based VQ and ABC based quantization and with standard LBG and Lloyd algorithm[24]. Comes about demonstrated higher Peak Signal-to-Noise Ratio (PSNR) showing better reconstruction[24]. Advanced cameras are extremely well known in the shopper gadgets market[24]. To streamline equipment cost, most advanced cameras catch a shading image with a solitary sensor in view of Bayer CFA as opposed to utilizing three sensors[24]. In this procedure, the caught image's pixels have just a single measured shading and such images are called mosaic images[24]. Different strategies are accessible in the writing for Bayer CFA image compression[24]. In this paper, a novel Vector Quantization (VQ) method was proposed which discovered better arrangement in the VQ space utilizing adjusted Artificial Bee Colony (ABC) improvement algorithm[24]. In this paper, biorthogonal wavelet was utilized to deteriorate the image, and an improved Vector Quantization procedure utilizing Artificial Bee Colony calculation and GA were likewise discussed[24]. The proposed

procedure can be utilized as a part of Digital Single Lens Reflex (DSLR) cameras to ideally transmit information utilizing remote connections[24]. This would be more successful than utilizing JPEG arrange where compression misfortunes were higher[24]. Tests are led with 6 images, each of size 256 by 256 and 8-bit power put away in tif design for different techniques[24]. The outcomes demonstrated that the proposed strategy beat and accomplished better BPP, MSE, CR, and PSNR than other methods[24]. Future work can be done to enhance the metaheuristic calculation parameters as it can be seen from test comes about that adjustment in calculation parameters produces distinctive outcomes however the deviation was not high[24].

## **Fast Vector Quantization using Bat Algorithm for Image**

### **Compression, Karri et.al [25]**

Linde–Buzo–Gray (LBG), a customary technique for vector quantization (VQ) creates a nearby ideal codebook which brings about lower PSNR value[25]. The execution of vector quantization (VQ) relies on upon the fitting codebook, so scientists proposed streamlining procedures for worldwide codebook generation[25]. Molecule swarm enhancement (PSO) and Firefly calculation (FA) produce an effective codebook, yet experiences flimsiness in meeting when molecule speed is high and non-accessibility of brighter fireflies in the pursuit space respectively[25]. In this paper, they proposed another calculation called BA-LBG which utilized Bat Algorithm on starting arrangement of LBG[25]. It delivered a proficient codebook with less computational time and results great PSNR because of its programmed zooming highlight utilizing flexible heartbeat emanation rate and commotion of bats[25]. From the outcomes, they watched that BA-LBG had high PSNR contrasted with LBG, PSO-LBG, Quantum PSO-LBG, HBMO-LBG and FA-LBG, and its normal joining rate is 1.841 times quicker than HBMO-LBG and FA-LBG however no importance distinction with PSO[25]. In this paper, a Bat calculation based vector quantization had been proposed for image compression[25]. The Peak flag to clamor proportion of vector quantization is streamlined by utilizing BA technique[25]. The calculation had been researched by shifting every single conceivable parameter of Bat calculation for effective codebook plan and proficient vector quantization of preparing vectors[25]. Increase and enhancement of the calculation are accomplished with Frequency-tuning and commotion parameter respectively[25]. It is watched that the Bat calculation top flag to clamor proportion and nature of the recreated image is better than LBG, PSO-

LBG, QPSO-LBG, HBMO-LBG and FA-LBG[25]. From the recreation comes about, it was watched that BA-LBG is around 1.841 times quicker joining rate than that of the HBMO-LBG and FA-LBG[25]. Nonetheless, The BA-LBG calculation requires some extra parameters contrasted and that of the PSO-LBG, QPSO-LBG and FA-LBG[25].

## **Image Compression Based On Vector Quantization Using Cuckoo Search Optimization Technique, Karri et.al [9]**

Most normal vector quantization (VQ) is Linde Buzo Gray (LBG), that outlines a nearby ideal codebook for image compression[9]. As of late firefly calculation (FA), molecule swarm advancement (PSO) and honey bee mating enhancement (HBMO) were composed which create close worldwide codebook, yet seek handle takes after Gaussian conveyance function[9]. FA encounters an issue when brighter fireflies are inconsequential and PSO experiences flimsiness in merging when molecule speed is exceptionally high[9]. Along these lines, we proposed Cuckoo look (CS) metaheuristic advancement calculation, that upgrades the LBG codebook by impose flight appropriation work which takes after the Mantegna's calculation rather than Gaussian distribution[9]. Cuckoo seek devours 25% of union time for neighborhood and 75% of joining time for worldwide codebook, so it ensures the worldwide codebook with suitable transformation likelihood and this conduct is the real value of CS[9]. For all intents and purposes we watched that cuckoo seek calculation has high pinnacle flag to commotion proportion (PSNR) and better wellness esteem contrasted with LBG, PSO-LBG, Quantum PSO-LBG, HBMO-LBG and FA-LBG at the cost of high union time[9]. In this paper, a cuckoo seek calculation based vector quantization was proposed for image compression[9]. The pinnacle flag to commotion proportion of vector quantization was amplified by utilizing CS algorithm[9]. The calculation had been examined by differing every single conceivable parameter of CS for proficient codebook plan and effective vector quantization of preparing vectors[9]. Increase and expansion of the calculation are accomplished with transformation likelihood and skewness parameter[9]. Heightening expects to look around the momentum best arrangements and to choose the best arrangements, while broadening ensures that the calculation can investigate the inquiry space all the more productively, regularly by randomization[9]. It was watched that the pinnacle flag to clamor proportion and nature of the recreated image acquired with CS calculation

were better than those got with LBG, PSO-LBG, QPSOLBG, HBMO-LBG and FA-LBG[9]. From the reproduction comes about it was watched that CS-LBG was around 1.425 times slower in meeting when contrasted with HBMO-LBG and FA-LBG[9]. Slower merging is the significant downside of the proposed method[9]. Notwithstanding, the CS-LBG calculation required less parameters than PSO-LBG, QPSO-LBG, HBMO-LBG and FA-LBG[9].

### **Engineering Optimisation by Cuckoo Search, Yang et.al [26]**

Another metaheuristic improvement calculation, called Cuckoo Search (CS), was grown as of late by Yang and Deb (2009). This paper displayed a more broad correlation examine utilizing some standard test capacities and recently de-marked stochastic test functions[26]. They then connected the CS calculation to tackle building outline enhancement issues, including the plan of springs and welded bar structures[26]. The ideal arrangements acquired by CS were obviously better than the best arrangements got by a productive molecule swarm optimizer[26].

### **Cuckoo Search via Lévy Flights, Yang et.al [27]**

In this paper, they planned to figure another meta-heuristic calculation, called Cuckoo Search (CS), for fathoming streamlining problems[27]. This calculation depended on the commit brood parasitic conduct of some cuckoo species in mix with the Lévy flight conduct of a few fowls and natural product flies[27]. They approved the proposed calculation against test capacities and after that contrast its execution and those of hereditary calculations and molecule swarm optimization[27]. At long last, they examined the ramifications of the outcomes and recommendation for further research[27].

### **Improved Cuckoo Search Algorithm for Global Optimization, Valian et.al**

The cuckoo seek calculation was an as of late created meta-heuristic advancement calculation, which is reasonable for understanding streamlining problems[28]. To upgrade the precision and union rate of this calculation, an enhanced cuckoo look calculation was proposed in this paper[28]. Ordinarily, the parameters of the cuckoo hunt are kept constant[28]. This may prompt diminishing the effectiveness of the calculation. To adapt to this issue, a legitimate system for tuning the cuckoo seek

parameters was presented[28]. Considering a few surely understand benchmark issues, numerical reviews uncover that the proposed calculation can discover better arrangements in examination with the arrangements acquired by the cuckoo search[28]. Accordingly, it was expected that the enhanced cuckoo look calculation can effectively be connected to an extensive variety of improvement problems[28]. In this paper, an enhanced cuckoo look calculation upgrading the precision and meeting rate of the cuckoo seek calculation was proposed[28]. The effect of keeping the parameters of the cuckoo look calculation steady was talked about and a technique for enhancing the execution of the calculation by appropriately tuning these parameters was presented[28]. As per the reenactment comes about, the proposed approach performed well in a few benchmark issues as far as the exactness of the arrangements found[28].

### **Adaptive image denoising using cuckoo algorithm, Malik et.al [29]**

This paper exhibited a novel denoising approach in light of smoothing straight and nonlinear channels joined with a streamlining algorithm[29]. The streamlining calculation utilized was cuckoo look calculation and was utilized to decide the ideal grouping of channels for every sort of noise[29]. Clamors that would be dispensed with shape images utilizing the proposed approach including Gaussian, spot, and salt and pepper noise[29]. The denoising conduct of nonlinear channels and wavelet shrinkage limit strategies had likewise been examined and contrasted and the proposed approach[29]. Comes about demonstrated the vigor of the proposed channel when contrasted and the best in class techniques as far as pinnacle flag to commotion proportion and image quality index[29]. Besides, a near investigation were given between the said enhancement calculation and the hereditary algorithm[29]. They proposed a half and half channel whose grouping was resolved by means of an enhancement calculation named as cuckoo pursuit algorithm[29]. Correlations were made among various denoising calculations and assessed as far as PSNR and IQI[29]. The method proposed in this paper had enhanced the execution of channels by utilizing them in a sequence[29]. This paper had investigated the CSA as a streamlining device and concentrated the conduct of various denoising calculations on various types of commotions at different clamor intensities[29]. The proposed approach outflanked different methodologies in expelling Gaussian, salt and pepper and dot noises[29]. All things considered 5–28 % ascend in PSNR is measured for

various commotions having shifting intensities[29]. Also, when contrasted and GA, there was a normal upgrade in PSNR of around 18% which copies in certain cases[29]. Henceforth, they inferred that the proposed technique adequately expels a wide range of commotions at different clamor intensities[29].

### **Constant SNR, Rate Control, and Entropy Coding for Predictive Lossy Hyperspectral Image Compression, Conoscenti et.al[30]**

Prescient lossy compression had been appeared to speak to an exceptionally adaptable structure for lossless and lossy installed compression of multispectral and hyperspectral images with quality and rate control[30]. In this paper, they enhanced prescient lossy compression in a few ways, utilizing a standard issued by the Consultative Committee on Space Data Systems, to be specific CCSDS-123, for instance of application[30]. To begin with, misusing the adaptability in the blunder control handle, they proposed a consistent flag to-clamor proportion calculation that limits the most extreme relative mistake between every pixel of the recreated image and the comparing pixel of the first image[30]. This was extremely helpful to maintain a strategic distance from low vitality regions of the image being influenced by substantial errors[30]. Second, they proposed another rate control calculation that has low many-sided quality and gives execution equivalent to or superior to existing work[30]. Third, they examined a few entropy coding plans that can accelerate the equipment execution of the calculation and, in the meantime, enhance coding efficiency[30]. These advances make prescient lossy compression a greatly engaging structure for locally available frameworks because of its effortlessness, adaptability, and coding efficiency[30]. In this paper, they had displayed a few changes over essential prescient lossy compression schemes[30]. Initially, they had proposed a calculation that permits performing lossy compression with limited relative blunder between any pixel of the first and recreated images[30]. The calculation is extremely straightforward, and it permits roughly or precisely implementing the client gave bound on relative error[30]. Second, they had proposed a straightforward and compelling rate control calculation, which enhances essentially on the cutting edge, by diminishing the many-sided quality and enhancing the performance[30]. Third, they had examined a few answers for entropy coding, showing the upsides of bit-plane-based entropy coding concerning other solutions[30]. These enhancements

made prescient lossy compression an extremely appealing answer for installed compression as far as both many-sided quality and performance[30].

## **Comparison of Neural Network Algorithms in Image Compression**

### **Technique, Perumal et.al[31]**

Image Compression system is extremely helpful for diminishing memory of capacity gadgets and to increment productive usage of transfer speed amid transmission of data[31]. Along these lines, they were making a correlation inside various calculation having a place with a similar group of neural networking[31]. To assess the most appropriate calculation for medicinal image compression among neural systems administration algorithms[31]. In this paper they considered Support Vector Machines (SVM) calculation, Radial Basis Function (RBF) calculation and Back Propagation (BP) they assessed the consequence of those calculations by using the parameters Such as Compression Ratio (CR), Execution Time, Signal to Noise Ratio (PSNR), Memory[31]. In light of got qualities they supported the best calculation among the chose three algorithms[31]. In this paper, three distinct calculations, for example, Support Vector Machines (SVM) calculation, Radial Basis Function (RBF) calculation and Back Propagation (BP) calculation were contrasted and image compression by utilizing restorative images[31]. These calculations were tried with entirely unexpected therapeutic images, for example, MRI, PET and figured tomography images by utilizing distinctive parameters like Compression Ratio (CR), Signal to Noise Ratio (PSNR), Memory, Execution Time, For each info size of the image 512\*512 and changing the contribution to each algorithm[31]. At long last, by assessing painstakingly every parameter through number of various images the estimations of three calculations. They know settling on a choice that the bolster vector machine of the neural systems administration family is the extremely viable among different calculations contrasted with it[31]. These procedures can be reached out with different calculations which won't go under the neural networking[31].

## **JPEG on steroids: Common Optimization Techniques For JPEG**

### **Image Compression, Richter [32]**

Notwithstanding its age, JPEG (formally, Rec. ITU-T T.81 — ISO/IEC 10918-1) is as yet the ubiquitous image document design for lossy compression of photographic images[32]. While its rate contortion execution is not focused with cutting edge plans



like JPEG 2000 or HEVC, complex strategies have been produced throughout the years to enhance its compression performance[32]. This article gave a short survey of the known advancements and assesses them on the premise of the JPEG XT demo usage accessible on the landing page of the JPEG committee[32]. It additionally puts the compression picks up into point of view of more present day compression configurations, for example, JPEG 2000[32].

## CHAPTER 3

### SCOPE OF STUDY

The audit on the current methodologies proposed by the analysts in Vector quantization for image compression has demonstrated a few confinements as follows:

1. Linde-Buzo Gray calculation (LBG): It doesn't guarantee for the ideal worldwide arrangements and the finishing up arrangement depend upon beginning codebook which is delivered haphazardly. LBG produces a neighborhood ideal codebook which closes in lower PSNR value.
2. Particle Swarm Optimization (PSO): It produces effective codebook however encounters insecurity in meeting when speed of molecule is high PSO can unite quick to the present best arrangement, yet not absolutely the worldwide best solutions.
3. Firefly Algorithm (FA): The result is dependably a powerful codebook however experiences in are an issue of non-accessibility of fireflies that brighter searching space.
4. Cuckoo Search (CS): The calculation confronts an issue with looking parameters that are settled and Mantegna's calculation utilized as a part of CS algorithm.

## CHAPTER 4

### PROBLEM FORMULATION

Enhancing the efficiency of cuckoo search using vector quantization for image compression as in our base paper [9] it is observed that cuckoo search is very slow as compared to other techniques. So, our main motive is to create the algorithm in such a way that we can get faster version of cuckoo search. The comparison will be done on the basis of PSNR (Peak Signal to Noise Ratio) and the computational time it takes with respect to increase in the codebook size.

In this paper [9] Cuckoo Search was hybrid with LBG (Linde-Buzo Gray) and created CS-LBG [9] for image compression. The results were compared with traditional techniques such as LBG, PSO-LBG, QPSO-LBG, FA-LBG, HBMO-LBG, BAT-LBG and after comparing with these technique a conclusion was made that Cuckoo Search is the best technique as it has very less parameters. But one limitation for this technique is that it is 1.425 times slower as compared to FA-LBG and HBMO-LBG approaches.

So, we observed that LBG algorithm makes the Cuckoo-Search slower as it had been concluded by Kekre's [16] algorithm also known as Kekre's Fast Code book Generation (KFCG) [16]. After analyzing every point we concluded that we will increase the efficiency of cuckoo search by using Kekre's Algorithm instead of LBG. We proposed the method in which Cuckoo-Search will be hybrid with Kekre's Algorithm. The research will be completed after comparing the results with the computational time as well as PSNR value given in [9] base paper.

## CHAPTER 5

### OBJECTIVES OF STUDY

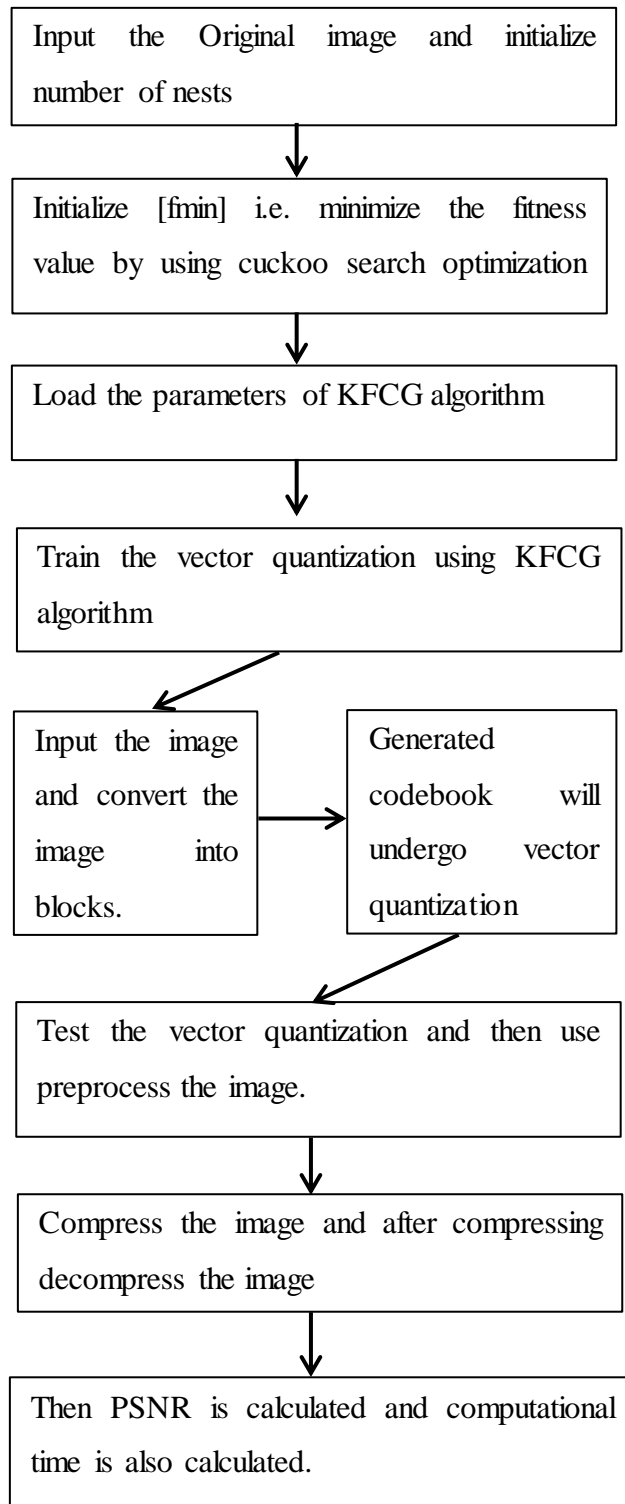
The objectives of our review are as follows:

- i. The point of investigation is to upgrade the current calculation of vector quantization for image compression by replacing the one procedure with the more dependable and efficient technique.
- ii. The desire of research is to reveal the responses to inquiries over the use of logical procedures.
- iii. The principle motivation behind research is to find reality which is concealed and which has not been imagined up 'til now, for example, our proposed methodology to upgrade the productivity of the current technique.
- iv. The desire of research is to determine the constraints of the current method with which either something happens or connected with something additional..

## CHAPTER 6

### RESEARCH METHODOLOGY

The input image is taken i.e. original image of  $n*n$  dimension. Then the number of nests for cuckoo search optimization will be initialized. After initializing nests minimum fitness value needs to be calculated. Simply, load the parameters of KFCG algorithm, codebook is generated using KFCG and then training the vector quantization takes place. The input image is converted into blocks and then testing of vector quantization takes place to use the preprocessing the image. Once preprocessing is done then compression and decompression of the image is initiated after all PSNR value is calculated and computational time is too calculated. Computational time actually vary according to the matlab version researcher is using as well as the processor on which the implementation is done. PSNR value is calculated within the implementation of the above procedure. It is said that to get the improved results we need higher PSNR value and lesser computational time.



**Figure 6.1 Stepwise View Of Proposed Methodology**

## CHAPTER 7

### RESULTS AND DISCUSSIONS

The implementation of the research methodology has been done on MATLAB tool 2014a with intel core i3 processor on B560 Lenovo laptop. The results are shown with the PSNR value and the computational time with different sizes of codebook i.e. 8, 16, 32, 64, 128, 256, 512, 1024. The image is converted into blocks. In our implementation the images are converted into 16 blocks each then the codebook is generated. The each block is then undergoes compression and decompressed which results in compressed reconstructed image. The reconstructed image has same dimensions as compared to input image. But the storage capacity of the reconstructed image less as compared to the original image. The results are observed on five images taken as input named as: Lenna, Goldhill, Barb, Pepper, Baboon. The respective PSNR values of our algorithm has been compared to the [9] base paper results



**Figure 7.1 Input Image LENNA**

The image above is LENNA image. This image is taken as input to the algorithm and then further codebooks of different sizes are generated. The compression and decompression is done on the image. The codebook of size 8 gave the PSNR value 23.3808 with computational time 174.099296 seconds. The computational time for codebook size 16 for LENNA image is 185.993895 seconds with PSNR value 24.5148. The computational time for codebook size 32 for LENNA image is 203.952254 seconds and PSNR value 25.4544.



**Figure 7.2 Decompressed Image of LENA for codebook size 8**



**Figure 7.3 Decompressed Image of LENA for codebook size 16**



**Figure 7.4 Decompressed Image of LENA for codebook size 32**





**Figure 7.5 Decompressed Image of LENA for codebook size 64**



**Figure 7.6 Decompressed Image of LENA for codebook size 128**



**Figure 7.7 Decompressed Image of LENA for codebook size 256**



**Figure 7.8 Decompressed Image of LENA for codebook size 512**



**Figure 7.9 Decompressed Image of LENA for codebook size 1024**

The computational time for codebook size 64 for LENA image is 240.004008 seconds and PSNR value 26.4762. The computational time for codebook size 128, 256, 512, 1024 for LENA image are 322.937744, 510.883191, 859.300051, 1605.711971 respectively and PSNR values are 27.2577, 28.3023, 29.3011, 31.4569 respectively.

Now the input image is Pepper and similarly the results have been observed for codebook sizes 8, 16, 32, 64, 128, 256, 512, 1024. The decompressed images with their PSNR values as well as computational time are mentioned below.



**Figure 7.10 Input Image PEPPER**



**Figure 7.11 Decompressed Image PEPPER for codebook size 8**



**Figure 7.12 Decompressed Image PEPPER for codebook size 16**



**Figure 7.13 Decompressed Image PEPPER for codebook size 32**

The computational time for codebook size 8 having input image Pepper is 175.789122 seconds and PSNR value 22.3587. The computational time for codebook size 16 having image as input name as Pepper is 185.993895 seconds and the PSNR value 23.5808. The computational time for codebook size 128 and 256 are 323.653066 seconds and 507.016188 seconds respectively as well as PSNR value for codebook size 128 and 256 are 26.9369 and 27.6712 respectively.



**Figure 7.14 Decompressed Image PEPPER for codebook size 64**



**Figure 7.15 Decompressed Image PEPPER for codebook size 128**



**Figure 7.16 Decompressed Image PEPPER for codebook size 256**



**Figure 7.17 Decompressed Image PEPPER for codebook size 512**



**Figure 7.18 Decompressed Image PEPPER for codebook size 1024**

The computational time for codebook size 512 and 1024 are 856.641703 seconds and 1532.606953 seconds respectively as well as PSNR value 29.0298 and 31.1208 respectively. Now the image is GOLDHILL as the original image and is decompressed.

The computational time for GOLDHILL input image for codebook size 8 is 871.163774 seconds with the PSNR value 25.4667. The computational time for codebook sizes 16, 32, 64, 128, 256, 512, 1024 are 927.438853, 1046.576760, 1245.464074, 1716.591729, 2693.921458, 2734.55678, 4034.512510 respectively as well as the PSNR values for the corresponding codebook sizes are 26.5239, 27.6127, 28.4234, 29.4047, 30.1955, 30.9915, 31.4049.



**Figure 7.19 Decompressed Image GOLDHILL for codebook size 8**



**Figure 7.20 Decompressed Image GOLDHILL for codebook size 16**



**Figure 7.21 Decompressed Image GOLDHILL for codebook size 32**



**Figure 7.22 Decompressed Image GOLDHILL for codebook size 64**



**Figure 7.23 Decompressed Image GOLDHILL for codebook size 128**



**Figure 7.24 Decompressed Image GOLDHILL for codebook size 256**



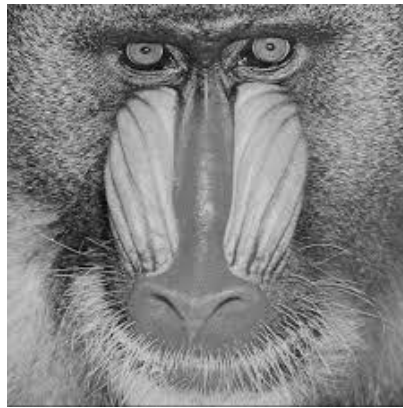
**Figure 7.25 Decompressed Image GOLDHILL for codebook size 512**



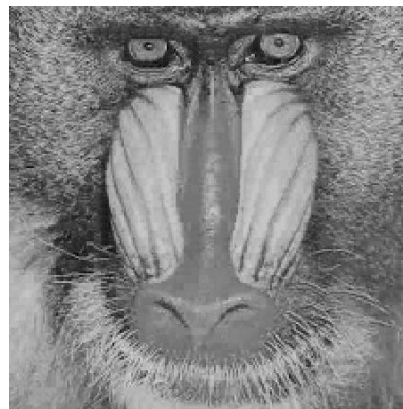


**Figure 7. 26 Decompressed Image GOLDHILL for codebook size 1024**

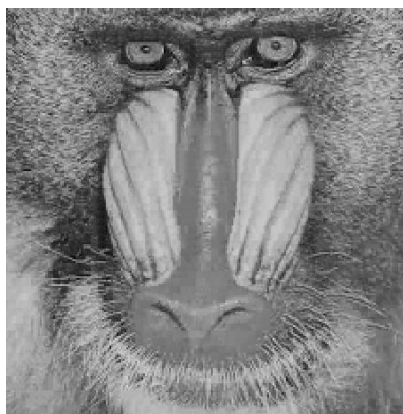
Now the next input image BABOON, BARB will be taken and then respective codebooks with their PSNR values is observed to conclude the results. Below are the decompressed images with different codebook sizes.



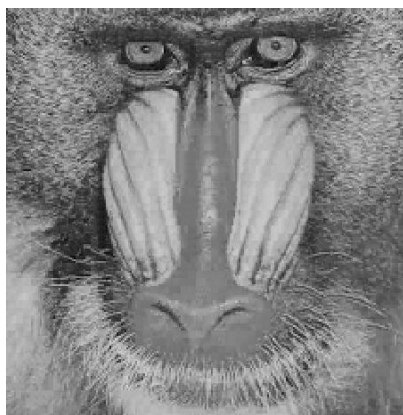
**Figure 7. 27 Input Image BABOON**



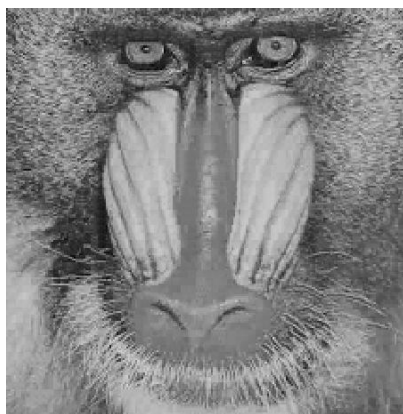
**Figure 7. 28 Decompressed image BABOON for codebook size 8**



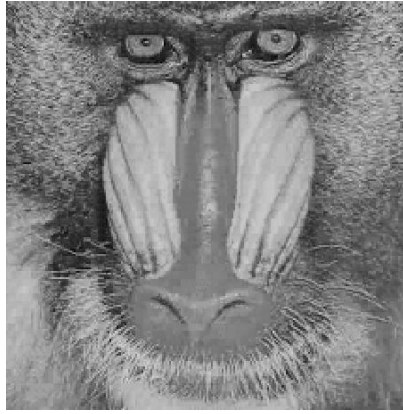
**Figure 7.29** Decompressed image BABOON for codebook size 16



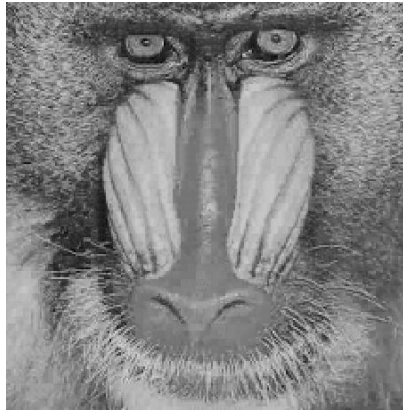
**Figure 7.30** Decompressed image BABOON for codebook size 32



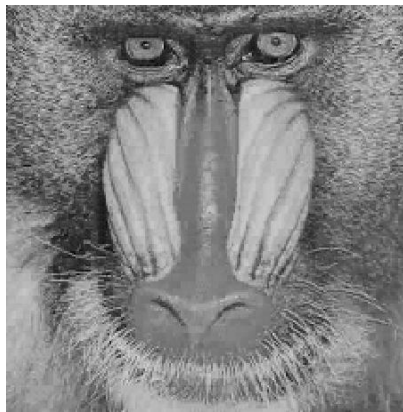
**Figure 7.31** Decompressed image BABOON for codebook size 64



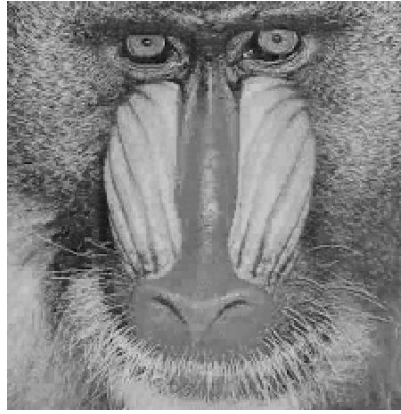
**Figure 7.32 Decompressed image BABOON for codebook size 128**



**Figure 7.33 Decompressed image BABOON for codebook size 256**



**Figure 7.34 Decompressed image BABOON for codebook size 512**



**Figure 7.35 Decompressed image BABOON for codebook size 1024**

The computational time for codebook of sizes 8, 16, 32, 64, 128, 256, 512, 1024 are 296.445679, 796.4456799, 896.3942389, 966.399211, 1122.349992, 1211.122999, 1308.299988, 1508.882999 respectively as well as the PSNR values are 25.4711, 26.5239, 27.6127, 28.2223, 28.2405, 28.2572, 28.3223, 28.4234.



**Figure 7.36 Input Image BARB**



**Figure 7.37 Decompressed Image BARB for Codebook size 8**



**Figure 7.38 Decompressed Image BARB for Codebook size 16**



**Figure 7.39 Decompressed Image BARB for Codebook size 32**



**Figure 7.40 Decompressed Image BARB for Codebook size 64**



**Figure 7.41 Decompressed Image BARB for Codebook size 128**



**Figure 7.42 Decompressed Image BARB for Codebook size 256**



**Figure 7.43 Decompressed Image BARB for Codebook size 512**



**Figure 7.44 Decompressed Image BARB for Codebook size 1024**

The computational time of respective codebook sizes i.e. 8, 16, 32, 64, 128, 256, 512, 1024 are 1021.4857, 843.545657, 943.776548, 912.486557, 1012.345658, 1143.243447, 1043.686227, 1543.486557.

**Table 7.1 Codebook Size 8 Comparision**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	3.371542	3.416869	4.313500	3.622867	3.843362
PSO-LBG	254.3579	247.181509	322.996476	247.211833	257.52053
QPSO-LBG	261.2993	252.652972	326.493443	346.986628	268.40318
HBMO-LBG	890.2543	676.344334	723.897865	681.978545	654.97667
FF-LBG	877.1238	660.141175	705.210035	661.281546	631.43536
CS-LBG	977.2009	1019.69757	1411.39200	1069.05775	1680.3341
CS-KFCG	174.0992	175.789122	296.445679	871.163774	1021.4857

**Table 7.2 Codebook Size 16 Comparision**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	3.405184	4.575627	4.537825	4.907262	4.391757
PSO-LBG	252.0015	250.411978	321.669194	318.004351	264.414665
QPSO-LBG	267.2082	253.430517	333.844743	376.746590	312.586584
HBMO-LBG	528.9954	567.656548	952.324245	589.097844	745.876776
FF-LBG	507.1830	534.304628	943.362724	574.986090	737.332125
CS-LBG	1006.583	1708.635425	1455.553349	1261.561267	1337.834255
CS-KFCG	185.9938	186.982859	796.4456799	927.438853	843.545657



**Table 7.3 Codebook Size 32 Comparison**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	5.262231	6.241595	5.171656	4.481844	6.675448
PSO-LBG	306.5320	338.618858	272.346143	277.087057	281.853149
QPSO-LBG	318.3141	272.908139	289.707195	313.025201	315.750745
HBMO-LBG	761.3466	571.875346	726.638634	779.098764	896.897654
FF-LBG	710.8108	594.783631	723.566566	755.606849	877.698960
CS-LBG	1316.946	1090.371821	1579.699665	1525.981190	1346.776353
CS-KFCG	203.9522	204.494225	896.3942389	1046.576760	943.776548

**Table 7.4 Codebook Size 64 Comparison**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	4.958598	5.768537	6.728556	8.795603	11.21273
PSO-LBG	311.4404	305.034406	314.850105	382.040368	308.216570
QPSO-LBG	320.1194	305.952327	323.926381	391.577189	312.251758
HBMO-LBG	745.3453	636.967533	775.232423	968.356788	874.778777
FF-LBG	711.4526	633.629908	768.088085	934.453184	846.853926
CS-LBG	1429.493	1531.719047	1507.091245	1907.092025	1369.893529
CS-KFCG	240.0040	240.416745	966.399211	1245.464074	943.486557

**Table 7.5 Codebook Size 128 Comparision**

Image → Algorithm ↓	LENA	PEPPER	BABOON	GOLDHILL	BARB
LBG	11.88853	16.421532	19.623416	15.216410	27.346822
PSO-LBG	522.2842	507.584419	405.582369	697.720161	521.941565
QPSO-LBG	534.0544	570.995410	465.000805	718.694109	531.267813
HBMO-LBG	889.3243	957.734356	964.673393	1180.36544	1164.09897
FF-LBG	866.0797	914.451402	920.112334	1122.441935	1145.650131
CS-LBG	1609.658	1876.924076	2195.838932	1457.215903	2044.023465
CS-KFCG	322.9377	323.653066	1122.349992	1216.591729	1012.345658

**Table 7.6 Codebook Size 256 Comparision**

Image → Algorithm ↓	LENA	PEPPER	BABOON	GOLDHILL	BARB
LBG	20.91328	18.116559	28.028078	29.701560	27.619608
PSO-LBG	875.9452	750.584419	594.620811	924.444311	683.999751
QPSO-LBG	894.6224	750.584419	563.620811	556.342111	692.899838
HBMO-LBG	799.3564	997.987876	1011.56545	843.534555	840.246767
FF-LBG	789.1384	972.207816	1032.44629	827.919726	830.791279
CS-LBG	1597.380	1707.318446	2006.820215	2932.646895	2555.872356
CSKFCG	510.8831	507.016188	1211.122999	2693.921458	1143.243447

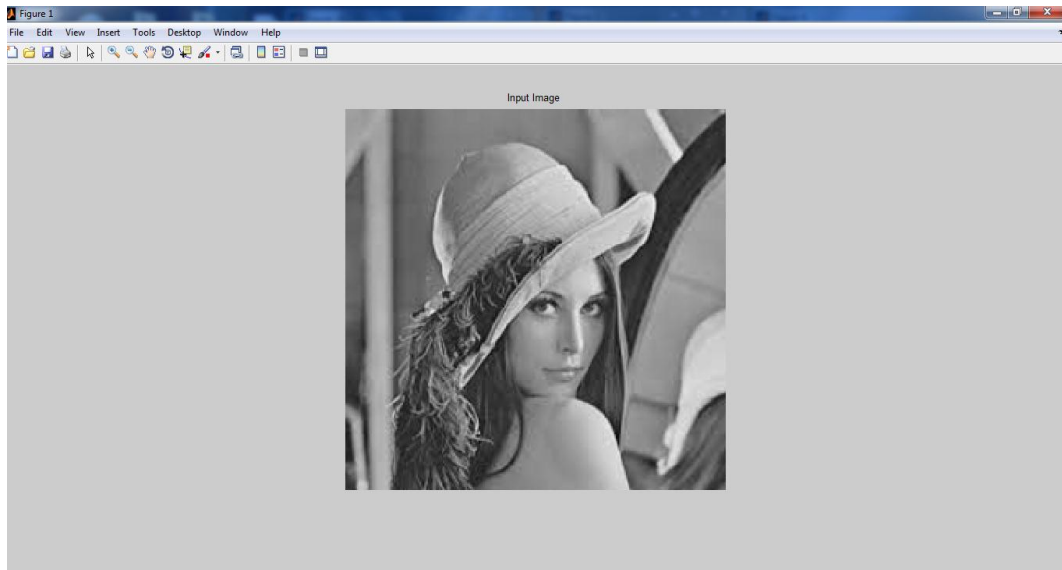
**Table 7.7 Codebook Size 512 Comparision**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	56.316994	82.002117	63.433322	77.850099	115.21079
PSO-LBG	1156.9085	1950.230780	2010.197209	1291.175546	1296.291040
QPSO-LBG	1196.3169	1851.809192	2187.580293	1332.753876	1123.215648
HBMO-LBG	1790.4445	1387.908655	2178.565466	2116.445100	1396.123567
FF-LBG	1716.8063	1357.86469	2212.438038	2126.344435	1386.554184
CS-LBG	2638.4377	2862.149227	3544.228924	2776.046559	2868.870087
CS-KFCG	859.30005	856.641703	1308.299988	2734.55678	1043.686227

**Table 7.8 Codebook Size 1024 Comparision**

Image → Algorithm ↓	LENNA	PEPPER	BABOON	GOLDHILL	BARB
LBG	145.7258	140.346789	156.576716	181.405248	211.115436
PSO-LBG	3422.799	2262.336878	3376.804469	2594.207355	2847.841612
QPSO-LBG	3518.889	2558.192815	3386.370076	2624.493640	2826.772350
HBMO-LBG	4290.667	2773.786877	3914.987866	2854.564565	2254.343435
FF-LBG	4229.809	2723.738130	3848.840251	2842.180938	2221.664446
CS-LBG	8272.419	4555.170085	5637.187818	4485.623620	4511.959378

The screenshot for the MATLAB tool interface is mentioned below in which there will be six figures incase of every input image but we have shown only for LENNA.



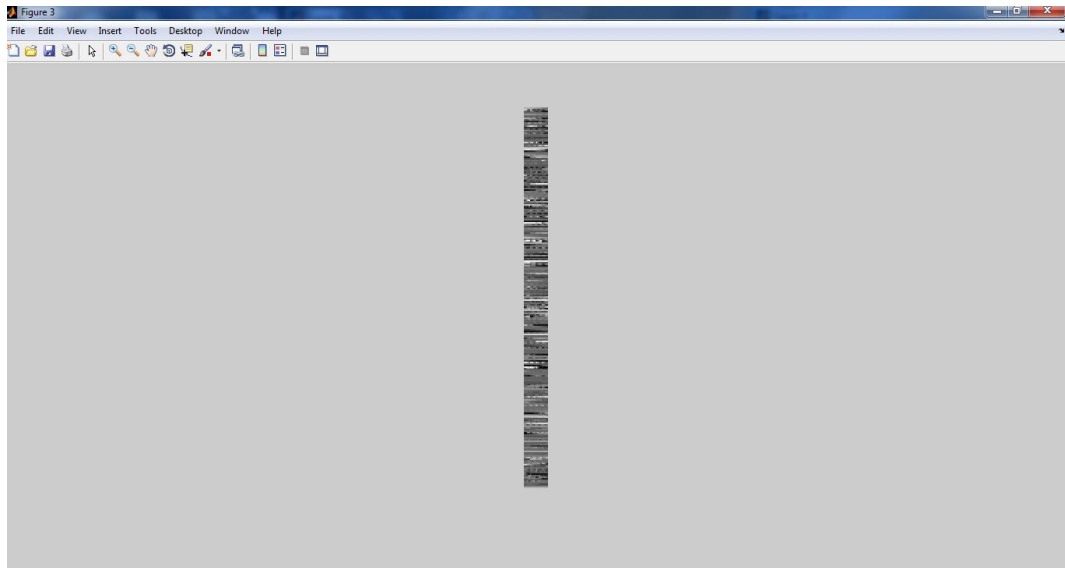
**Figure 7.45 The input image on MATLAB interface**

In this the input image is Lenna which is given as input to the system for compressing it. The size of the input image here is of size  $256 \times 256$  also known as original image. Now the image will be converted into blocks here in our work it will be converted to 16 blocks.

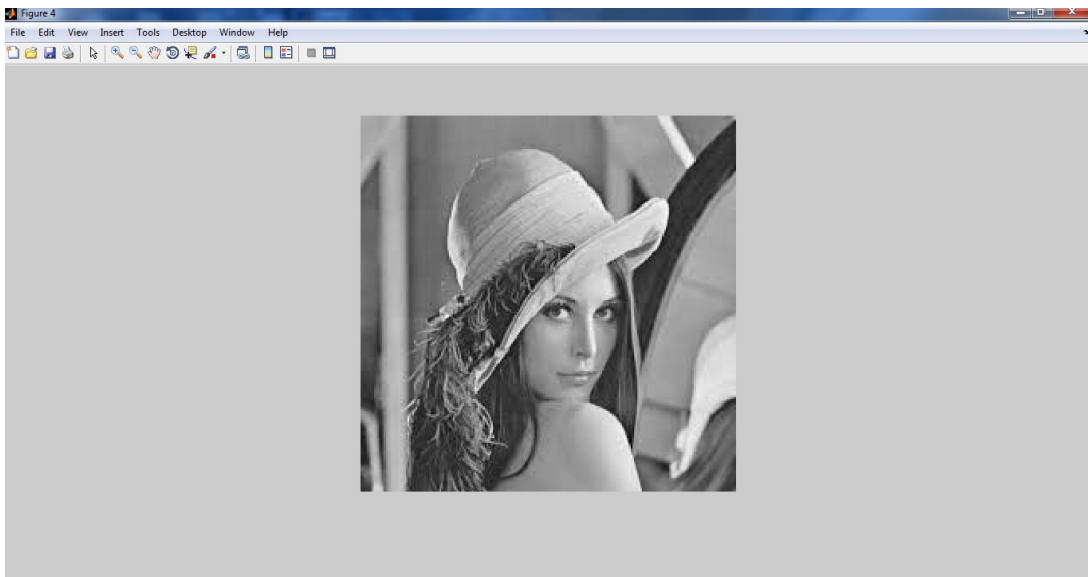
In Figure 7.46 the codebook is generated. The size of the codebook in this case is  $256 \times 16$ , then in Figure 7.47 the input image with different dimensions is shown, the dimension of the image is reduced to  $224 \times 224$ .

Then after this process the input image is converted into 16 blocks and all the preprocessing and other algorithms are applied to compress the image so the compressed image is shown in the Figure 7.48

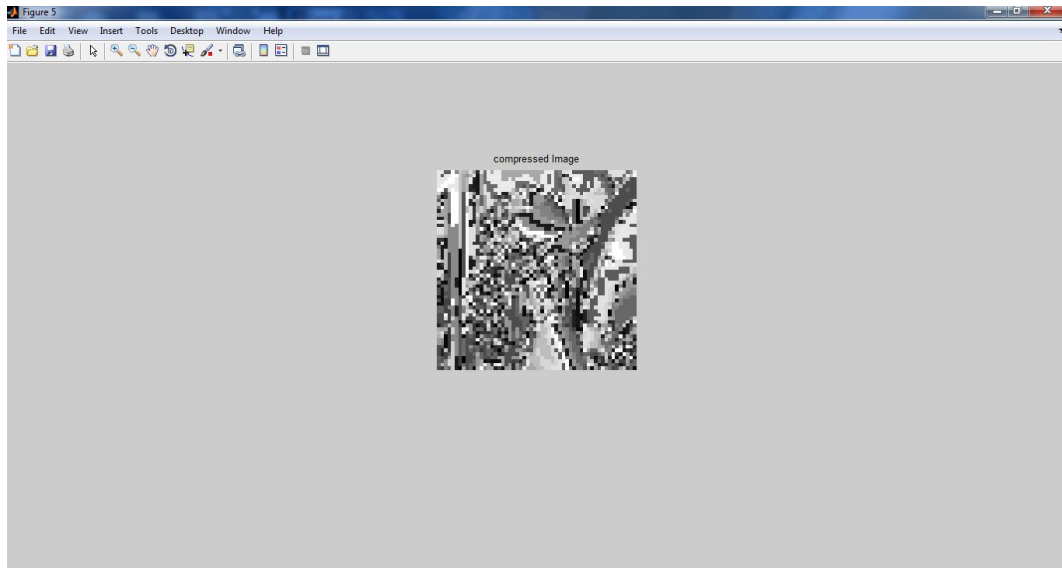
After, compression the decompression is done and that too is shown in Figure 7.49 and finally when all the iterations for all the blocks is done then the graph is plotted according to their PSNR values. Graph is shown in Figure 7.50



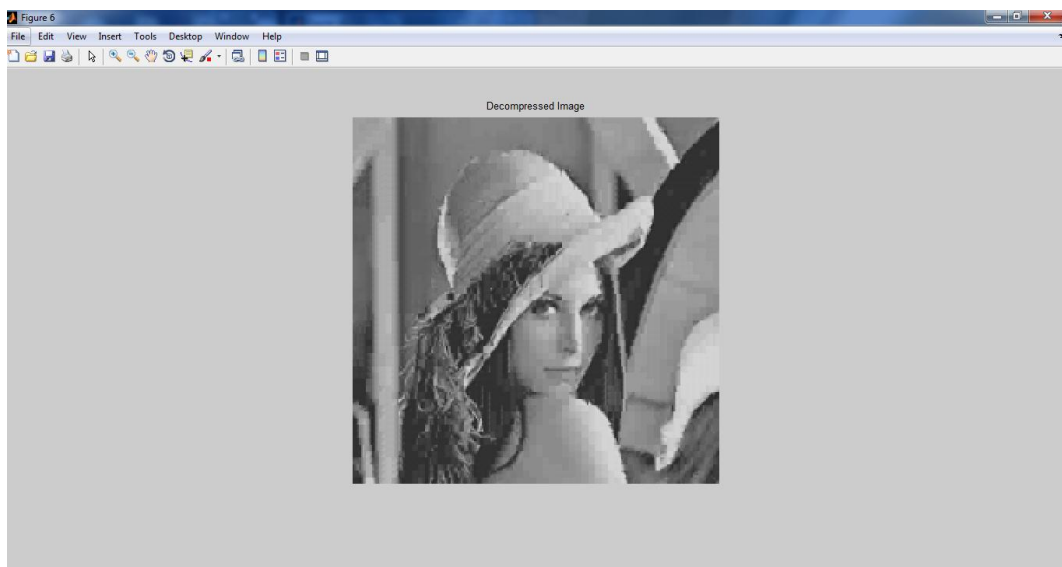
**Figure 7.46 Codebook of size 256\*16**



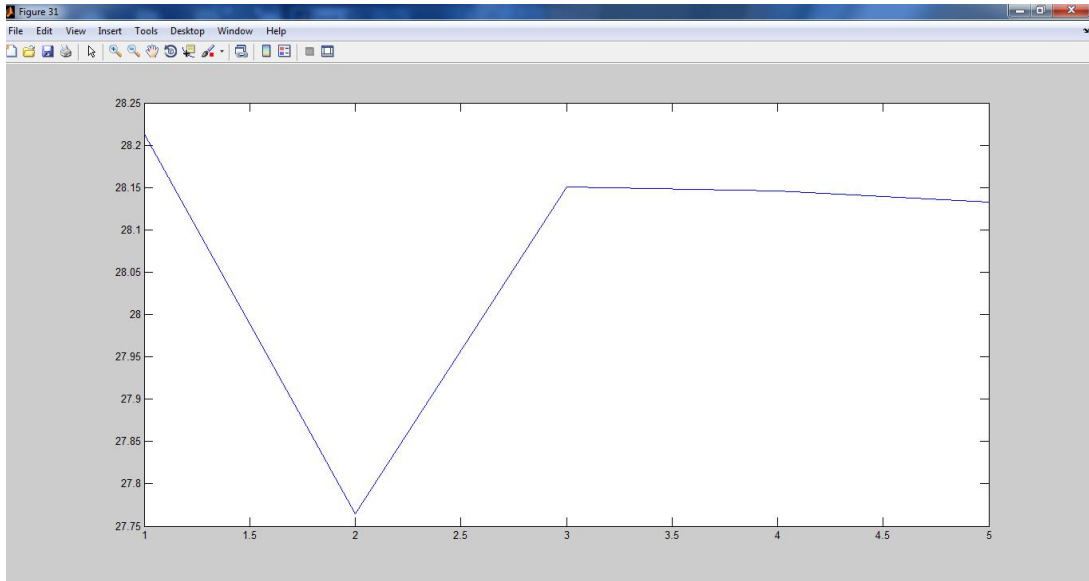
**Figure 7.47 Input Image of dimension 224\*224**



**Figure 7.48 Compressed Image of size 56\*56**



**Figure 7.49 Decompressed Image of size 224\*224**



**Figure 7.50 Graph with different PSNR values**

**Table 7.9 PSNR Comparison w.r.t. LENNA**

Codebook size → Algorithms ↓	8	16	32	64	128	256	512	1024
LBG	23.0	23.9	24.9	25.3	25.4	25.8	25.8	25.9
PSO-LBG	23.0	24.3	25.0	25.4	25.5	25.9	25.9	28.9
QPSO-LBG	23.1	24.2	25.1	25.5	25.7	26.2	26.8	29.2
HBMO- LBG	23.1	24.1	25.0	25.7	25.9	26.4	26.7	29.4
FA-LBG	23.2	24.1	25.2	25.8	26.1	26.7	27.3	29.5
CS-LBG	23.3	24.3	25.2	25.9	26.7	27.5	28.2	29.8
CS-KFCG	23.4	24.5	25.4	26.4	27.2	28.3	29.3	31.4

In Table 7.9 comparison on PSNR values w.r.t. Codebook sizes has been considered on LENNA image. The main comparison is done between CS-LBG and CS-KFCG algorithms. The values are taken from basepaper and our algorithm values have been noted from the output. In Figure 7.51 the graph has been plotted to show the comparison.

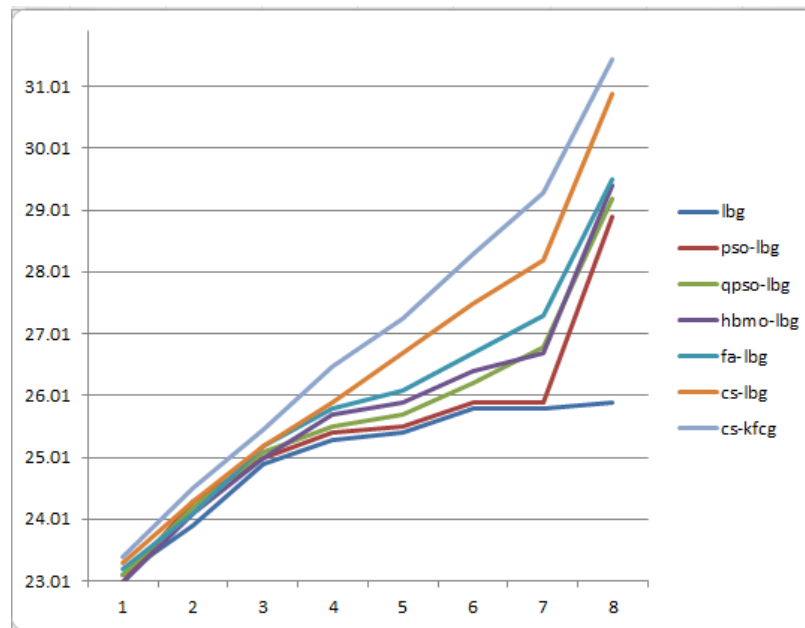


Figure 7.51 Comparison Graph of PSNR for LENA

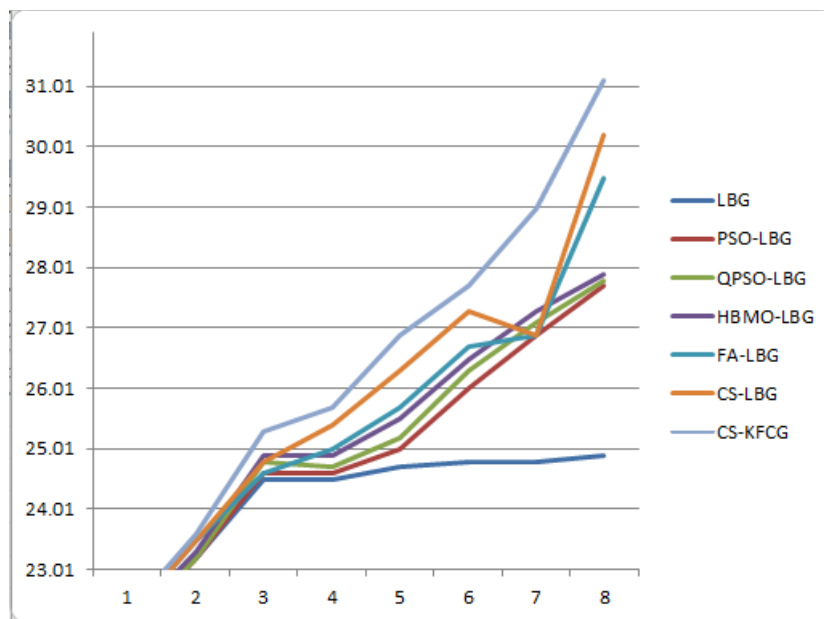


Figure 7.52 Comparison Graph of PSNR for PEPPER



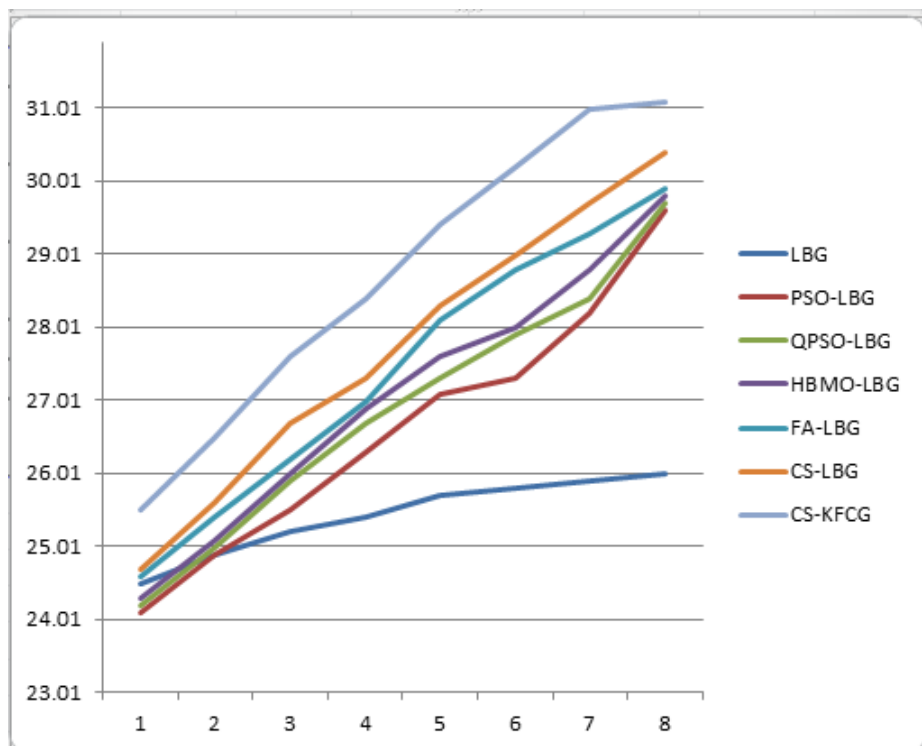
**Table 7.10 PSNR Comparison w.r.t. PEPPER**

Codebook size → Algorithms ↓	8	16	32	64	128	256	512	1024
LBG	22.0	23.2	24.5	24.5	24.7	24.8	24.8	24.9
PSO-LBG	22.0	23.2	24.6	24.6	25.0	26.0	26.9	27.7
QPSO-LBG	22.0	23.2	24.8	24.7	25.2	26.3	27.1	27.8
HBMO- LBG	22.1	23.3	24.9	24.9	25.5	26.5	27.3	27.9
FA-LBG	22.2	23.5	24.6	25.0	25.7	26.7	26.9	29.5
CS-LBG	22.2	23.5	24.8	25.4	26.3	27.3	26.9	30.2
CS-KFCG	22.3	23.6	25.3	25.7	26.9	27.7	29.0	31.1

In Table 7.10 comparison on PSNR values w.r.t. Codebook sizes has been considered on PEPPER image. The main comparison is done between CS-LBG and CS-KFCG algorithms. The values are taken from basepaper and our algorithm values have been noted from the output. In Figure 7.52 the graph has been plotted to show the comparison. In Table 7.11 comparison on PSNR values w.r.t. Codebook sizes has been considered on GOLDHILL image. The main comparison is done between CS-LBG and CS-KFCG algorithms. The values are taken from basepaper and our algorithm values have been noted from the output. In Figure 7.53 the graph has been plotted to show the comparison. In Table 7.12 comparison on PSNR values w.r.t. Codebook sizes has been considered on BABOON image. The main comparison is done between CS-LBG and CS-KFCG algorithms. The values are taken from basepaper and our algorithm values have been noted from the output. In Figure 7.54 the graph has been plotted to show the comparison.

**Table 7.11 PSNR Comparison w.r.t. GOLDHILL**

Codebook size → Algorithms ↓	8	16	32	64	128	256	512	1024
LBG	24.5	24.9	25.2	25.4	25.7	25.8	25.9	26.0
PSO-LBG	24.1	24.9	25.5	26.3	27.1	27.3	28.2	29.6
QPSO-LBG	24.2	25.0	25.9	26.7	27.3	27.9	28.4	29.7
HBMO-LBG	24.3	25.1	26.0	26.9	27.6	28.0	28.8	29.8
FA-LBG	24.6	25.4	26.2	27.0	28.1	28.8	29.3	29.9
CS-LBG	24.7	25.6	26.7	27.3	28.3	29.0	29.7	30.4
CS-KFCG	25.5	26.5	27.6	28.4	29.4	30.2	31.0	31.1



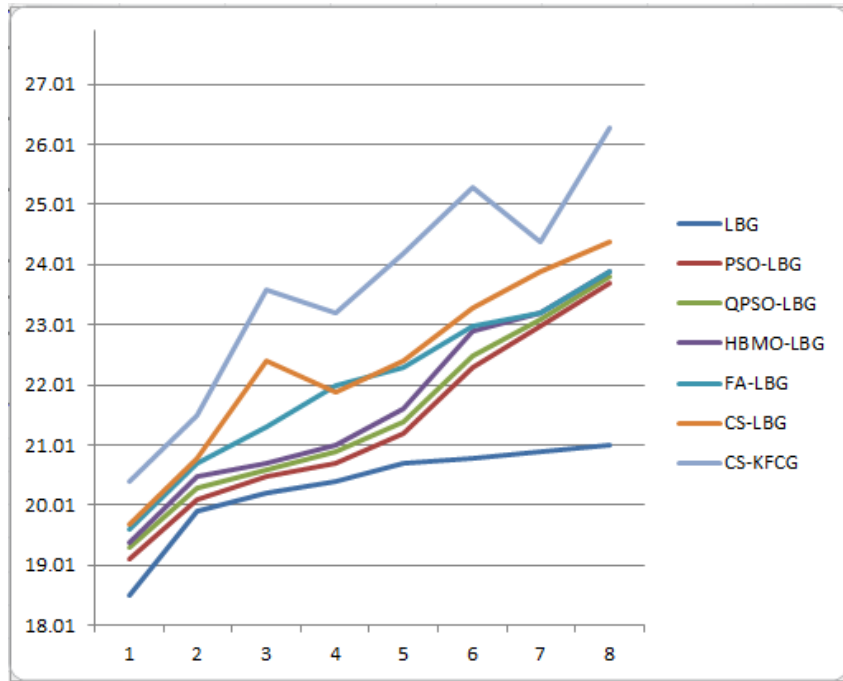
**Figure 7.53 Comparison Graph of PSNR for GOLDHILL**

**Table 7.12 PSNR Comparison w.r.t. BABOON**

Codebook size → Algorithms ↓	8	16	32	64	128	256	512	1024
LBG	18.5	19.9	20.2	20.4	20.7	20.8	20.9	21.0
PSO-LBG	19.1	20.1	20.5	20.7	21.2	22.3	23.0	23.7
QPSO-LBG	19.3	20.3	20.6	20.9	21.4	22.5	23.1	23.8
HBMO-LBG	19.4	20.5	20.7	21.0	21.6	22.9	23.2	23.9
FA-LBG	19.6	20.7	21.3	22.0	22.3	23.0	23.2	23.9
CS-LBG	19.7	20.8	22.4	19.9	22.4	23.3	23.9	24.4
CS-KFCG	20.4	21.5	23.6	23.2	24.2	25.3	24.4	26.3

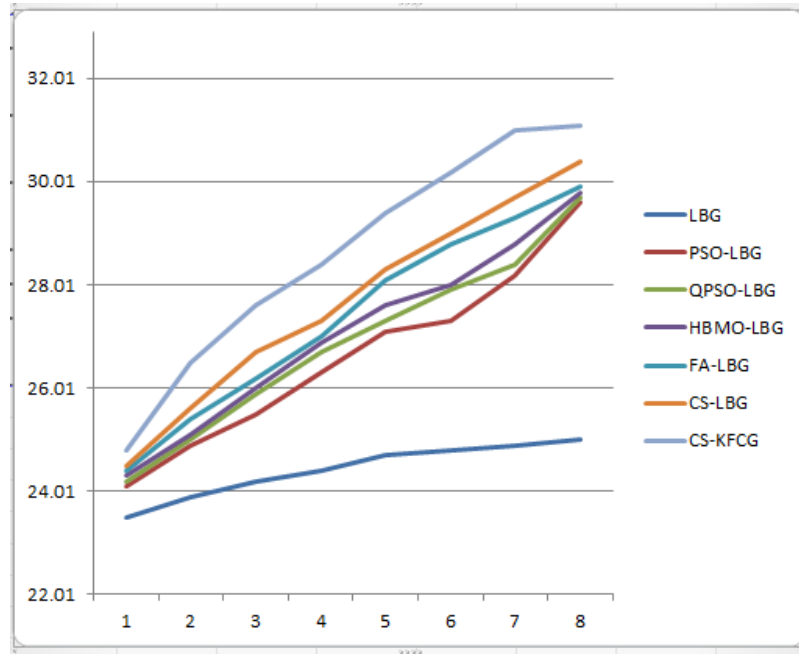
**Table 7.13 PSNR Comparison w.r.t. BARB**

Codebook size → Algorithms ↓	8	16	32	64	128	256	512	1024
LBG	24.5	24.9	25.2	25.4	25.7	25.8	25.9	26.0
PSO-LBG	24.1	24.9	25.5	26.3	27.1	27.3	28.2	29.6
QPSO-LBG	24.2	25.0	25.9	26.7	27.3	27.9	28.4	29.7
HBMO-LBG	24.3	25.1	26.0	26.9	27.6	28.0	28.8	29.8
FA-LBG	24.6	25.4	26.2	27.0	28.1	28.8	29.3	29.9
CS-LBG	24.7	25.6	26.7	27.3	28.3	29.0	29.7	30.4
CS-KFCG	25.5	26.5	27.6	28.4	29.4	30.2	31.0	31.1



**Figure 7.54 Comparison Graph of PSNR for BABOON**

In Table 7.13 comparison on PSNR values w.r.t. Codebook sizes has been considered on BARB image. The main comparison is done between CS-LBG and CS-KFCG algorithms. The values are taken from basepaper and our algorithm values have been noted from the output. In Figure 7.55 the graph has been plotted to show the comparison.



**Figure 7.55 Comparison Graph of PSNR for BARB**

## CHAPTER 8

### CONCLUSIONS AND FUTURE SCOPE

Through our results we conclude that our algorithm CS-KFCG is much faster than CS-LBG as the computational time of our proposed methodology is much less as compared to CS-LBG. The results were proved on five images and in each case the computational time is less as compared to CS-LBG[9].

So, our main objective was to enhance the efficiency and to overcome the limitation of CS-LBG algorithm[9]. Through, our results we have obtained our main objective. Moreover, we have compared our results with the base paper's results [9]. In our work we have noticed one limitation that the decompressed image of codebook size 8 and 16 does not give the clear or good quality image. As the codebook size increases respectively the quality of the decompressed image increases.

In future scope, we will try to overcome the limitation of our work. This can be used in image compression applications such WhatsApp, Facebook, e-mail etc. This approach can be used in compressing videos too. There are many applications that compresses the videos and audios this technique may be used by the coders to create the new applications for compressing videos, audios etc.

Finally, it is concluded that our proposed algorithm CS-KFCG is superior as compared to CS-LBG.

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